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House Science Committee Holds Hearing on Future of Human Space Flight

BOEHLERT:

The markup will come to order. Good morning. The committee will be in order.

Pursuant to notice, the Committee on Science is meeting today to consider the following measures -- and certainly, don't get nervous, this will be brief and then we'll get right to the main attraction here today -- House Resolution 395, recognizing the importance of chemistry to our everyday lives and supporting the goals and ideals of National Chemistry Week, and House Concurrent Resolution 279, recognizing the significance of the anniversary of the American Association for the Advancement of Science, Congressional Science, and Engineering Fellowship Program, and reaffirming the commitment to support the use of science in governmental decision-making through such programs.

I ask unanimous consent for the authority to recess the committee at any time, and without objection, it is so ordered. This markup will be very brief so that we can get to our important hearing.

We are marking up two non-controversial resolutions, one recognizing the 30th anniversaries of the fellows program run by the American Association for the Advancement of Science, and one recognizing American Chemistry Week.

These are both worthy endeavors that deserve congressional recognition. And I appreciate that Dr. Ehlers has introduced the AAAS resolution, and Dr. Houghton, who is a former AAAS fellow, has introduced the chemistry resolution. I think these resolutions speak for themselves. The only thing I would note is that we

recognize the value of the AAAS program here daily, as many of our staff members began their careers on the Hill as fellows.

To take just three prominent examples, the minority Chief of Staff Bob Palmer and both of my deputy chiefs of staff, John Mimikakis and Peter Rooney, were AAAS fellows. Hopefully, everyone will view that as an advertisement for the program. I look forward to the speedy passage of these resolutions through this committee and the House.

I now recognize Mr. Gordon to present any opening remarks he might care to present.

GORDON:

Mr. Chairman, I will place Mr. Hall's opening remarks in the record, and let us move forward.

BOEHLERT:

Without objection, so ordered.

I now recognize Dr. Ehlers as the sponsor of both resolutions before the committee, and the Environment, Technology, and Standards Subcommittee chairman, for any opening remarks that he may have.

EHLERS:

Mr. Chairman, in the interest of time, I will not read the entire statement, but I ask that both statements be entered in the record in full.

BOEHLERT:

Without objection, so ordered. All members may place opening statements in the record at this point in time.

Is there anything else you'd care to say?

EHLERS:

Yes, Mr. Chairman. Are we taking up both simultaneously, or are we proceeding ad seriatim?

BOEHLERT:

We're taking one at a time, but we're doing, first, the chemistry.

EHLERS:

First, the chemistry. Let me just make a few comments. Thank you, Mr. Chairman.

Today, I'm pleased that we are marking up this resolution, recognizing the importance of chemistry in our everyday lives. This resolution supports the goals and ideals of National Chemistry Week, that recognizes the important contributions of chemical scientists and engineers to technological progress and the health of many industries.

I particularly wanted to commend the American Chemical Society for establishing National Chemistry Week in 1987. I would also like to commend the American Chemical Society for setting an example for other professional societies in its work, trying to make science relevant to the public and increasing and improving science education throughout the country.

The theme of 2003, "Earth's Atmosphere and Beyond," was chosen to honor the 100th anniversary of Orville and Wilbur Wright's flight

from Kitty Hawk, North Carolina. It's really important to stimulate children's interest in this week, as well as the activities of the various chemical societies is important in this endeavor. I urge my colleagues to support this resolution.

BOEHLERT:

Thank you, Dr. Ehlers.

Dr. Gingrey?

GINGREY:

Thank you, Mr. Chairman.

As a chemistry graduate, National Science and Chemistry from the Georgia Institute of Technology, and also a graduate of the Medical College of Georgia, I certainly am very happy with this resolution and what the American Chemical Society has done in starting National Chemistry Week back in 1987, and realize how important it is to emphasize what chemistry really means to our society.

I know we are concerned about our youngsters, and I have four adult children now who held their nose, I'm sure, when they had to sign up for chemistry either at the high school or college level. And I'm sure that most of our youngsters probably are more familiar, might be more familiar with Orville Redenbacher than Orville Wright. But it is very important to emphasize what chemistry means to our society.

And as a member of this science committee, with that background, I understand the importance of the contributions of chemistry. It affects our everyday life, as it is the core of every technology that we enjoy. Chemical scientists and engineers are central to contributing to the technological progress and the health of many industries that drive our economy, like pharmaceuticals, electronics,

agriculture, automobile, and aerospace sectors -- and I could go on and on.

So I commend the 10,000 nationwide volunteers that will go out next week and educate millions of children through hands-on science activities in local schools, libraries, and museums, and our teachers, who promote chemistry everyday in our classrooms.

And I thank you, Mr. Chairman, for...

BOEHLERT:

Thank you, Dr. Gingrey.

The chair would note that both Orvilles have made significant contributions that enrich our society.

The chairman recognizes Ms. Johnson.

JOHNSON:

Thank you very much, Mr. Chairman.

I would just ask unanimous consent to place my statement in the record.

BOEHLERT:

Without objection, so ordered. And all members have permission to do so at this juncture. I ask unanimous consent that we will now consider H.Res. 395. I ask unanimous consent that the resolution is considered as read and open to amendment at any point. Without objection, so ordered.

Are there any amendments?

Hearing none, the question is on the resolution. House Resolution 395, recognizing the importance of chemistry to our everyday lives and supporting the goals and ideals of National Chemistry Week. All those in favor say aye. All those opposed say no. In the opinion of the chair, the ayes have it.

I will now recognize Mr. Gordon to offer a motion.

GORDON:

Mr. Chairman, I move that the committee favorably report House Resolution 395 to the House with the recommendation that the resolution be agreed to. Furthermore, I move that the staff be instructed to prepare the legislative report to make necessary technical and conforming changes, for the chairman to take all necessary steps to bring the resolution before the House for consideration.

BOEHLERT:

The question is on the motion to report the resolution favorably. Those in favor of the motion will signify by saying aye; opposed, no. The ayes have it. And the resolution is favorably reported. Without objection, the motion to reconsider is laid upon the table.

I move pursuant to clause 1, Rule 22 of the rules of the House of Representatives, that the committee authorize the chairman to offer such motions as may be necessary in the House to adopt and pass House Resolution 395. Without objection, so ordered.

We will now consider House Concurrent Resolution 279. I ask unanimous consent that the concurrent resolution be considered as read and open to amendment at any point. Without objection, so ordered.

Are there any amendments? Hearing none, the question is on a concurrent resolution.

Dr. Ehlers?

EHLERS:

Thank you, Mr. Chairman -- just a few words of explanation. Today, I'm pleased that we are marking up this resolution, recognizing the 30th anniversary of the Congressional Science and Engineering Fellowship Program, coordinated by the American Association for the Advancement of Science. It recognizes a truly valuable educational program that gives scientists a wonderful opportunity to step out of the lab and into the political process.

By working as legislative assistants in congressional offices, the scientists get a good idea on how Congress operates. At the same time, members of Congress, and other policymakers, gain a valuable new resource to help them better understand the scientific and technical issues underpinning complex policy debates.

Six different fellows have served on my staff, and each one used their unique talents and understanding to help shape my legislative agenda and, therefore, this committee's legislative agenda. It's a wonderful program that has helped the Congress. It has brought some very bright, young and middle-aged people into the Congress to help us, and I urge my colleagues to recognize the success of this program by supporting this resolution to honor the AAAS Congressional Fellowship Program.

BOEHLERT:

Thank you, Dr. Ehlers.

Is there anyone else who seeks recognition? Dr. Palmer, Dr. Mimikakis, and Dr. Rooney, and all the other AAAS fellows that

daily enrich the offerings of this committee and add immensely to the intellectual capital available in this confine, this one is for you.

Are there any amendments? Hearing none, the question is on the House Concurrent Resolution, House Concurrent Resolution 279, recognizing the significance of the anniversary of the American Association for the Advancement of Congressional Science and Engineering Fellowship Program, and reaffirming the commitment to support the use of science in governmental decision-making through such programs.

All those in favor say aye, opposed nay. In the opinion of the chair, the ayes have it.

I will now recognize Mr. Gordon for a motion.

GORDON:

Mr. Chairman, I move that the committee favorably report House Concurrent Resolution 279 to the House with the recommendation that the resolution be agreed to. Furthermore, I move that the staff be instructed to prepare the legislative report, make necessary technical informing changes, and that the chairman take all necessary steps to bring the concurrent resolution before the House for consideration.

BOEHLERT:

The question is on the motion to report the concurrent resolution favorably. Those in favor of the motion will signify by saying aye, opposed no. The ayes have it, and the resolution is favorably reported. Without objection, the motion to reconsider is laid upon the table.

I move, pursuant to clause 1 of Rule 22 of the rules of the House of Representatives, that the committee authorize the chairman to offer

such motions as may be necessary in the House to adopt and pass House Concurrent Resolution 279. Without objection, so ordered. That concludes our markup.

Now we get to the main event.

I want to welcome everyone here this morning to this important hearing. At our previous hearings on the Columbia accident, both witnesses and members repeatedly made the point that NASA has suffered from the lack of a clear national vision for the future of human space flight. Over the long term, NASA will be successful only if it is pursuing a clear and broad national consensus, with sustained and adequate funding.

As the Columbia Accident Investigation Board noted in its report, that hasn't been the case for three decades. Now, we ought to admit that one reason such a consensus has been lacking is that it's hard to reach, and even harder to pursue, over time. We need to be candid and realistic about that in our discussions today. And our vision can't be based on some dreamy, historical view that we can recreate the Apollo era.

I, personally, don't know yet what that vision for the future of human space flight should be. Today's hearing is just the beginning of our efforts to build a national consensus. But I do think there are some principles and ideas we need to keep in mind as we develop a consensus.

First, any consensus has to be arrived at jointly by the White House and the executive branch, the Congress and, of course, NASA. And the consensus has to include an agreement to pay for whatever vision is outlined. In many respects, we have the easiest task. It's easy for us to follow this program on a daily basis -- are totally immersed in it, to have a grand vision and authorize tons of money to help us achieve that vision.

But it does no good if we just do our job and the appropriations don't follow, and the administration doesn't follow with the appropriate budgetary requests. NASA needs to do its part by coming up with credible cost estimates and schedules for projects, something that has been sorely lacking in recent decades, and something that has not been done yet for the next major human space flight project: the orbital space plane.

Second, we need to keep in mind that human space flight is not the only NASA responsibility or, as far as I'm concerned, the most important of its responsibilities -- important, though, it is. I think the Augustine Commission got it right back in 1990 when it listed space science and Earth science as NASA's top priorities and added several more activities in order of importance before it got to human space flight.

Third is a related point: NASA will not have an unlimited budget. The federal government has too few resources and too many obligations to give NASA a blank check. Any vision that assumes massive spending increases for NASA is doomed to fail. That is especially true in the near future, when the focus should be on getting the agency's house in order to carry out its current task.

Fourth, we need to be honest about the purposes and challenges inherent in human space flight. Our witnesses today are pretty honest in their testimony on this point, and we thank them for that. The primary reason for human space flight is the human impulse, some would say destiny, to explore. Human exploration is not necessarily the best way to advance science or technology, and it certainly is the most expensive and riskiest way to do so.

I would add that nothing about China's launch -- and we congratulate the Chinese for the success of that mission -- alters these statements.

Fifth, we need to learn from the mistakes we've made over the past 30 years. The space shuttle and the space station are remarkable

achievements, something we are all too prone to forget. But they are also extraordinarily expensive projects -- mind bogglingly expensive, compared to the original estimates -- and they haven't performed as advertised or done as much as hoped to advance human exploration or knowledge.

We have to avoid going down the same paths in the future. So we need to be thoughtful, and deliberate, and coldly analytical in putting together a vision for the future of human space flight. It has to be a long-term vision. We're not about to embark on any crash program. The technical challenges alone are enough to prevent that.

We have assembled today an extraordinary panel to help us sort these issues out, and I look forward to hearing from them.

The chair recognizes the distinguished ranking member, the gentleman from Texas, Mr. Hall.

HALL:

Mr. Chairman, thank you for that good statement, and I'm going to put my statement in the record. It's one of the best ones I've ever read, and I really recommend it to the rest of the committee and to all who have access. But in the interest of time, and because of the excellent panel that we have -- and I was going to even quote Dr. Griffin.

I'll go and put his quote in there, when he said, "The international faith and credibility of the United States is tied, in part, to the orderly completion of the International Space Station. We must complete its construction to include the original seven-man crew capability and establish a utilization plan for the facility that returns as much value as possible."

And the last thing says, "I believe we have the means to start an exciting chapter in human exploration. We just need to decide where we want to go, and then get started."

I'll yield some time to the chairman of the Space Subcommittee, and yield back my time, when he finishes with his time, that I'm lending him out of my time. Is that understandable?

BOEHLERT:

Are you yielding to Mr. Rohrabacher or Mr. Gordon?

HALL:

Well, either one of them.

BOEHLERT:

The chair recognizes the distinguished ranking member of the Subcommittee on Space.

HALL:

And I ask that my entire -- be placed in the record.

BOEHLERT:

We would not miss that opportunity.

HALL:

Thank you, sir.

BOEHLERT:

Without objection, so entered.

GORDON:

Thank you, Mr. Chairman, and thank you, Mr. Hall, for yielding your time.

Let me first say that I listened to our chairman's remarks with interest, and I want to say that I thought they were thoughtful. I concur. I think that it is a good benchmark for all of us and --

HALL:

Don't (inaudible) too much. He's hard to live with.

GORDON:

Well, in this one, he was right. And I think that if we follow that lead, we will go in a very good direction. We do need to get on and hear the witnesses, so let me just add my quick welcome. There's a couple of issues that I would like to hear discussed today.

First, while I am obviously not an expert in these matters, it seems to me that having a base on the moon would be a useful step for a variety of reasons, one of which certainly would be to further human space exploration. If nothing else, such a base would be needed to test many of the technologies and techniques required for human exploration. And I would like to know your feelings on that.

Also, the NASA administrator says his vision for exploration is not about destinations. Instead, NASA will, first, develop technologies and then decide where to go. Somehow that seems backwards to

me. It seems to me that unless we are willing, first, to commit to some concrete goals, NASA's technology investments are likely to be unfocused, inefficient, and wind up costing more than necessary.

In addition, the reality is that technology programs that are not tied to specific and agreed upon mission goals become very vulnerable to budget cuts, or even cancellation over time. So as you go through your remarks, I hope that you can address these two issues. And thank you very much for being here with us today.

BOEHLERT:

Thank you very much, and all the other members of the committee I leave to enter your remarks in the record at this juncture.

And we'll go right to our very distinguished panel of witnesses:

Dr. Michael D. Griffin, president and chief operation officer of In-Q-Tel, Inc.; Dr. Wesley T. Huntress Jr., director, geophysical laboratory, Carnegie Institute of Washington; Dr. Matthew B. Koss, assistant professor of physics, College of Holy Cross; Dr. Alex Roland, professor of history, Duke University; and Dr. Bruce Murray, professor of planetary science and geology emeritus, California Institute of Technology.

Let me say at the outset how much we appreciate all of you being resources for this committee. We're here to listen, we're here to learn; we're here to have a dialogue as we develop a future vision for this important program.

With that, Dr. Griffin, you're up first. And I'd ask that you try to confine your opening remarks -- and the chair will not be arbitrary -- to five minutes or so, which will give us ample opportunity to have the dialogue I referred to.

Dr. Griffin?

GRIFFIN:

Thank you, Mr. Chairman, and members of the committee, for inviting me to appear here, and this opportunity to discuss the vision, goals and the future of human space flight.

I believe it is time to begin discussing what we should do and not what we've done wrong.

I believe that the human space flight program is, in the long run, possibly the most significant activity in which our nation is engaged. For what, today, do we recall Renaissance Spain's King Ferdinand and Queen Isabella? Unless one is a professional historian, the memory which is evoked is of their sponsorship of Columbus and his voyages of discovery.

For what, in 500 years, will our era be recalled? We will never know, but I believe it will be for the Apollo lunar landings, if for anything at all. And this is entirely appropriate. Human expansion into space is a continuation of the ancient human imperative to explore, to exploit, to settle new territory, when and as it becomes possible to do so. This imperative will surely be satisfied by others if not by us.

It may be argued that we have many difficult problems in greater need of immediate attention and resources than is human space flight. I agree with this argument. But even recognizing its reality, space flight is sparingly funded. In round numbers, FY 2003 U.S. budget outlays were approximately $2.1 trillion, while the U.S. population is currently just under 300 million, yielding an average liability for our outlays of $7,000 per person, or about $20 a day for every man, woman, and child in the nation.

With the NASA budget at $15 billion a year, the civil space program costs each person in the nation about $50 a year, or less than 14 cents per day. A really robust space effort could be had for a mere 20 cents a day from each person. I spend more than that on chewing gum. We, as a nation, quite literally, spend more on pizza than we do on space exploration.

So I don't think we're over-spending on space. As wealthy as the United States is, it is certainly true that we can allocate only a small fraction of that wealth to the development of human space flight. But in my opinion, we must allocate that fraction and we must spend it wisely. I don't think we're doing either.

I feel compelled to note that although there are technical challenges, they do not seem to me to be the biggest problem that we have. We did not retreat from the moon because of technical difficulties, we have not failed to go to Mars because of technical problems, and we have not taken 20 years to put a space station in orbit because of technical matters.

In each case, the issues are matters of politics and leadership. Without a bipartisan, leadership-driven consensus that a vigorous space exploration program is essential to America's future, we will not have such a program, whether or not there are technical challenges to be overcome. It has been 40 years since a chief executive has propounded such a vision and made it stick, and no Congress has ever taken the initiative to do so. If the nation's leaders cannot say that exploration is important, and why, it will not occur.

This new ocean, to use John F. Kennedy's famous phrase, has recently become accessible to us, albeit at great cost and difficulty. But despite the difficulty, it will be explored, it will be settled by humans. The only questions are: which humans and when? While the answer to the first question will eventually be all humans, I'm parochial enough to believe that those from our nation should be in the vanguard.

So, in recognizing that others may differ, for me, the single overarching goal of the human space flight program is the human settlement of the solar system and, eventually, beyond. I can think of no lesser purpose sufficient to justify the difficulty of the enterprise, and no greater purpose is possible.

With that, I stand ready to take your questions. Thank you very much.

BOEHLERT:

Thank you very much, Dr. Griffin.

Dr. Huntress?

HUNTRESS:

Mr. Chairman, members of the committee, I'm grateful for this opportunity to testify before you all today on my view of the future of this planet's human space flight program.

I believe that the American public wants an adventurous space program to new, exciting destinations in the solar system and beyond. The challenge is to move outward beyond the Earth to these exotic places -- places where we've been given tantalizing glimpses from our robotic exploration program.

The shuttle and the space station are the legacy of a long-passed era, in which the space program was a weapon in the Cold War. The Apollo program was not, primarily, the science or exploration program we're all fond of remembering. It was a demonstration of the power and national will intended to win over the hearts and minds around the world, and to demoralize the old Soviet Union.

Exploration was not what motivated Kennedy to open the public purse: beating the Russians did. Apollo accomplished that, and the nation moved on to other priorities, which did not include what the space enthusiasts, and much of the public, thought would happen: lunar bases, or on to Mars.

The imperatives are very much different today. Three decades of wishful thinking and building space ambitions on an inadequate funding basis has led us into a blind alley. The space station is not the expected transportation mode for missions beyond the Earth

that it was supposed to be. It has become an Earth-orbital end unto itself. The space shuttle is not the low-cost, low-risk, operational space transportation system that it was supposed to be.

I think that the legacy of the Columbia accident should be to create a new pathway and a sense of purpose for human space flight. And if space explorers are to risk their lives, they should do so for challenging reasons, such as exploring the moon, Mars, asteroids, or for constructing and servicing space telescopes. The whole point of leaving home, after all, is to go somewhere, not to endlessly circle the block.

What the public wants is clarity of purpose. A space station advertised as the next logical step, without filling in that blank "to what," just doesn't do it. Now, there is a growing consensus that a coherent vision for human space flight over the next several decades is required, and one that has a clear sense of purpose and destination.

Sooner or later, we have to have a clear destination or human space flight won't survive, and America will be much the poorer for it. A new option doesn't have to be funded like Apollo. It can proceed at a steady pace. A country needs the challenge of grander explorations to justify the risk and to lift our sights, to fuel human dreams, and to advance human discovery and knowledge.

We need to go somewhere. Now, as a scientist, when I ask why we need such an enterprise, I start with very public questions such as, where do we come from, what will happen to us in the future, and are we alone in the universe? And these, then, define the scientific objectives required to answer them, and these objectives, in turn, determine what kind of exploration is needed and which destinations. And my answer is there are four.

And they're (inaudible) it's the destination of choice for our future space telescopes, such as the James Webb telescope -- the moon, nearest asteroids and, ultimately, Mars. Mars, of course, is the most

challenging, the most distant. And I identify it, really, as the most scientifically rewarding and the one place that can galvanize human interest like no other.

It's the logical destination for humans in the next decades of this new century. It's the most Earthlike of all the planets in our solar system. It may have had life earlier in its history. It might possibly harbor microbial life below the surface today. And one day, in the future, it may become a new home for humankind. It's fascinated humans for centuries, and it's within our reach.

In pursuing these destinations, do we use human or robotic missions? The answer has always been both. Both these enterprises have coexisted and cooperated during the entire history of the space program. Science cost-effectiveness is not a good metric for human versus robotic modes. And human exploration of space is really motivated by a lot more than science, but by more societal factors. And a space exploration program that the public requires does want humans in space.

The bottom line is that the human space flight program needs to be set on a new path that leads to a future that the public has been expecting for decades, a path that takes humans beyond orbit to new, important destinations. We need a national vision that sets a destination for human exploration, and then systematically pursues this fulfillment with both robotic and human space flight.

Thank you for your attention.

BOEHLERT:

Thank you very much, Dr. Huntress.

Dr. Koss?

KOSS:

Mr. Chairman, members of the Science Committee, thank you very much for inviting me to address you here today. I am honored by your request.

Like many Americans, I sat riveted to the television station that Saturday morning, when the Space Shuttle Columbia and her crew failed to return home. I was stunned and saddened, and I was left wondering, 'How could this have happened?'

As a scientist, I had participated in three of Columbia's previous missions. I had worked with several of Columbia's crew on their previous missions. I felt a special kinship to the Columbia and her crew. In a curious way, I felt that the Columbia was my shuttle, and so it was a deeply shocking experience to watch the television that morning.

But then, another feeling sort of occurred to me. I ended up asking myself, as a scientist who had participated in these missions, in these dedicated science missions, was I in any way responsible for what had happened? And I feel I was in some way responsible. I was part of the larger NASA culture that contributed to these missions.

I was responsible for not saying what I had known privately and I had discussed with other scientists. And that is that we did not need human beings to assist in the exercise of these physical science experiments. They run well autonomously. I had worked with NASA, I had been charged by NASA to build and test autonomous and remote controlled systems, and they had worked flawlessly.

And although I had presented papers and talked about how successful autonomous programs were, I never connected the dots and said, "Well, maybe we should reconsider the use of humans in space."

I feel now that almost all of the physical science experiments that are performed on-orbit could be done autonomously or remotely. I

think the Columbia Accident Investigation Board has it right. Not only should we reverse the burden of proof in terms of not requiring that someone shows the shuttle not safe to fly, but requiring that it is affirmatively proven that it is safe to fly.

I think the science experiments need the same exacting standards. If there's a science experiment that needs human involvement, the scientists backing that program need to have a preponderance of evidence that says so. However, if there were no access to the space station or space shuttle, vital research in material science would be halted. It would not necessarily be halted forever, but it would certainly be halted, and there would be an interim period. And I believe the same could be said for other sciences in the physical science portfolio at NASA.

At present, there is simply no alternative to those platforms. I've heard a free-flyer or an autonomous platform discussed, but I don't believe there's any commitment to it at this time. I don't have the necessary expertise or financial knowledge to give you a detailed estimate of what that facility would cost. I'm an assistant professor at a small liberal arts college. I clearly don't know very much about money.

I do know something about the tradeoff that would occur if one developed an autonomous program. And when I look at all those tradeoffs in sum total, I reach the conclusion that the tradeoffs favor the development of an autonomous platform, a remote platform for orbital physical science experiments.

It is unlikely that the larger mission that my fellow panelists are talking about would help the physical sciences on-orbit program. These sciences that I represent, or that I know about, are laboratory sciences that are really concerned with the inner workings of, let's say, materials. I support a future manned program; it just is not to the betterment of the science I'm currently pursuing.

I think NASA has the skills to develop an autonomous program. I think it's important that they do, and I'd like to see that happen.

Again, I thank you for your invitation to address you here today.

BOEHLERT:

Thank you very much, Doctor.

Dr. Roland?

ROLAND:

Thank you, Mr. Chairman.

The United States may have a long-term future in human space flight. But in the near term, however, human space flight should be suspended, in my opinion, or at least drastically curtailed. If the shuttle flies at all, it should fly unmanned or, at worst, with a minimal crew.

The space station should be mothballed or converted to a space platform, a research facility to be visited periodically for refueling, maintenance, and changing experiments. The upcoming mission to refurbish the space telescope should be canceled, or flown only by the astronauts actually conducting the repairs. For the foreseeable future, all orbiting scientific instruments should be designed to function untended and be launched on expendable launch vehicles to their optimal orbit.

The problem, of course, is the shuttle. Humans may one day fly to Mars and beyond, but it won't be on the shuttle. While the shuttle is a technological marvel, it's also the world's most expensive, least robust, and most deadly launch vehicle. On average, one astronaut dies for every eighth flight. I don't know of any transportation system, not even an experimental system, approved to operate with such a record.

After the Challenger disaster, the Rogers Commission, and every other body that studied the accident, gave NASA the same advice. First, do not rely on the shuttle as the mainstay of the space program. It's too expensive and too fragile to ever fill that goal. Second, begin at once to develop a replacement vehicle.

Sixteen years later, the Columbia disaster found NASA massively dependent on the shuttle, with no replacement vehicle in sight. The shuttle has never been, and never will be, the launch vehicle that NASA wants it to be. Yet, the agency appears determined to return to business as usual.

At least for the short term, we do not need the shuttle and we do not need people in space. Anything we want to do in space we can do more cheaply, more effectively, more safely with automated spacecraft monitored and controlled from Earth. The reason is simple: whenever people are put on a spacecraft, its mission changes. Instead of exploration, or science, or communication, or weather, the mission of spacecraft becomes life support, and returning the crew alive.

This limits where the spacecraft can go, how much equipment it can carry, how long it can stay, what risks it can take in pursuit of its mission. The net impact of people on the spacecraft is to greatly limit its range and capabilities without adding any value that can begin to compensate for these drawbacks.

A rough rule of thumb first introduced by NASA Associate Administrator George Lowe in the Apollo program is that putting people on a spacecraft multiplies tenfold the cost of the undertaking. For more than 40 years, NASA has been sending humans and machines into space. It has spent about two-thirds of its funds on human space flight, about one-third on automated spacecraft.

The most important returns, after Apollo, have come from the machines -- the space probes, the scientific satellites, the communications, the Odyssey, weather satellites. The return on

manned space flight has been mostly psychological -- a kind of public entertainment based on flying the astronauts as an end in itself. NASA used to call this the next logical step, envisioning a succession of manned projects, culminating in a mission to Mars.

Now, NASA says that it has achieved, quote, "a permanent human presence in space." It has not made clear what the people are to do there, other than to take their own pulse in an endless round of experiments to understand the physiological risks of flying to Mars and back. Before we can fly to Mars, we must first master flight to low-Earth orbit. Indeed, if we were to commit tomorrow to a human mission to Mars, it would still cost more to get to low-Earth orbit than it would to get all the rest of the way to Mars and back.

This is the real obstacle to our future in space. It's the obstacle the shuttle was supposed to overcome. After 30 years, and tens of billions of dollars, it is clear that the shuttle will never be the vehicle NASA promised. We must recognize that reality, scrap or severely curtail shuttle operations, and get on with the challenging but promising business of building the launch vehicle or vehicles we need.

Thank you, Mr. Chairman.

BOEHLERT:

Thank you very much.

Dr. Murray?

MURRAY:

Thank you, Mr. Chairman, and members of the committee.

MURRAY:

I'm very, very pleased that you're undertaking these hearings because, indeed, the problem is one of vision -- as I noticed this

committee room has permanently imprinted on its walls behind you -- and from that, a willingness to really look at what that means. And so, I'm coming from that point of view.

I have been involved in space exploration for 40 years, mostly using automated systems, but I've been a strong advocate of human space exploration of Mars. That's been hard to do at NASA, and so I, personally, have used the Planetary Society, a private non-profit advocacy group, as a platform in which to pursue that.

The reason it's been so hard to deal with NASA -- and this goes back to 1983, '84 -- in my own memory, was you'll always get the statement from them, "We'll think about that after space station is completed." NASA has had that as its mantra. It's been focused on that. Of course, the shuttle is part of that.

And the consequence is, as everyone seems to agree, the U.S. is bogged down in low-Earth orbit. What is needed here is not so much technology. I don't think it's primarily a financial problem. It's a perspective problem on ourselves. It takes some realistic assessments of program alternatives, and it takes a lot of political courage. The latter is a part that you can both contribute to directly and, certainly, contribute to indirectly, but building public, governmental consensus about what to do.

I believe that the way out of this is that main bog down: low- Earth orbit. Until and unless we really embrace a long-term destination for humans in space, there is no point, in the long run, of doing what we're doing now. That's simple. We're bogged down not just technically, but we're bogged down in terms of purpose.

It's tragic when people die in that purpose. It's not tragic, it's sad when people die, say, in a military conflict of great importance. But it's very sad when they die doing something that isn't really worth doing with humans, and that doesn't, itself, advance us. The only thing that will advance us is the idea that we are reaching, as a country, and in that sense, leading the world in a broader sense, out

on an important destination, which is to determine whether or not, in this case, Mars, which is the only potentially habitable place outside of Earth, if Mars is a potential habitat, potential venue for human activities in the future, that's the dream.

It may not be true; we don't know. We can tell a lot by robots, and we're learning many good things. For example, the recent Odyssey results, revealing the presence of water-ice in the soil near the surface over much broader parts of the planet is really important. But we won't know whether we can make that a place to begin for human activity until humans go and try to do it.

That should be their objective. It should not be to go demonstrate technology, go to place the American flag there, and whatever. That's the Apollo thinking from a different era. It was very successful then, but it was that kind of thinking which created the 1989 attempt -- the only other attempt to do something like this -- such a disaster, politically and every other way, because it wasn't the right reason.

So we have to embrace the right reason. We have to embrace the fact that this is something that's going to take a while. You're not going to get it done in two presidential cycles or how many congressional ones. So that means that the program itself has to be composed of a lot of short term milestones and efforts, each of which is enabling to the longer goal, each of which is affordable, and each of which is interesting and popular.

That's the key of this dilemma. That's how we get out of it. In order for that to happen, NASA is going to have to feel pressure to produce alternatives to the current space station/shuttle plan. It's clear they are committed to that, as they have been, but they don't see a way out of it. And so they're going to sit there and try as best as possible to stay on that track.

If they're successful, it means that human space flight will probably disappear, either gradually, by loss of interest, or catastrophically, when the next fatalities occur, either on the shuttle or in the station

itself. We're that close. It would be terrible, and it's a horrible legacy of this generation, of this political leadership of which you're a part, that we could lose this wonderful thing we started with, especially Apollo.

We could lose it because we didn't have the political courage to recognize that we've gotten ourselves in an unsupportable situation. I have testimony, and I'm looking forward to answering detailed questions on how to do all this. But I leave you with both thanks for having a chance to talk to you, and saying that, fundamentally, the problem is your problem.

It's a political leadership problem, a perceptual problem. It's not a financial problem; it's not a technical problem.

Thank you very much, Mr. Chairman.

BOEHLERT:

Thank you, Dr. Murray.

You know, everybody talks about vision. I translate that to mean a grand strategy. But the vision or the grand strategy doesn't mean anything if it isn't a shared vision. Right now, it's a blurred vision, and we've got to bring it into sharper focus.

And one of the things that I was taken by in the CAIB report -- and it said rather specifically, the budget didn't match NASA's priorities. Well, in that instance, it seems to me that NASA has to face the reality and rethink its priorities to address that dollar flow. That hasn't happened.

And the easiest part is our part on this committee. You know, we can develop the grand strategy, the grand vision, and we can authorize money and, virtually, unlimited dollar amounts. But what good is that if it's not supported by a budget request from the administration or it isn't supported by the actual dollars from the Appropriations Committee?

So we're all talking about the same thing. We've got to all get on the same wavelength, and I'm afraid we're not there yet, and we've got a lot of work cut out for us.

Here's a general question for all witnesses. In '90, the Augustine Commission laid out a set of priorities if NASA's budget was flat. Those priorities were space science, one; two, Earth science -- we used to call it mission to planet Earth -- three, technology development; four, development of a heavy lift launch vehicle; and five, human space exploration -- we used to call it mission from planet Earth.

Do you agree with those priorities? If not, can you give us a new set of priorities? And what level of funding would NASA need to begin to implement your vision?

Dr. Griffin, I'll start with you. That's a tall order.

GRIFFIN:

Thank you, sir.

I agree that all those priorities are useful things to do. I would not have them in that order, as I think is probably pretty clear from my earlier remarks.

BOEHLERT:

Would you care to share your order?

GRIFFIN:

If I were to use these same ones, my order would be, the chronological order in which I would do them certainly would be, start with developing a heavy lift launch capability, because without that, there is no human exploration program, which I would then place second.

I would place space science third, Earth science fourth, and possibly, surprisingly, technology fifth. I don't really mean that technology is the fifth most important thing. What I intend to imply is that technology advancement, not tied to specific goals and accomplishments, I think, is wasted money. And so, when one undertakes to reach certain destinations or achieve certain goals, whatever, whether they be in space science, Earth science, human exploration, or whatever -- reaching those goals entails, usually, doing things we don't currently know how to do.

And then, we implement the technology programs necessary to get there. But developing technology absent specific goals, to me, is just wasteful.

BOEHLERT:

In your testimony, you state specifically, we need to see an allocation of about $20 billion per year, and then you go on to list what you hope to achieve with that $20 billion, and the list is pretty extensive. Do you think we could accomplish all of the above for $20 billion a year?

GRIFFIN:

Yes, sir, I do. I think the question is when, as I also indicated in the more extensive written remarks. I do believe NASA needs an incremental funding over what they've had in real dollars. Of course, it has dropped quite substantially over the last few decades. I think the things that I have listed -- I guess this is a tautology -- are the right things to be doing, or I would not have listed them.

They are the things that I believe the space agency was chartered to accomplish. I hear remarks -- I've heard some on this panel today -- that imply that we need to reduce or curtail space flight. It's not NASA's job to figure out how to do less space flight. NASA was chartered to figure out how to do space flight. We need to re-vector

them so that they are working on the proper things, but they, in my view, need to be given all possible encouragement to do it.

BOEHLERT:

Dr. Huntress, you want to weigh in?

HUNTRESS:

Yes. Some 10 years after the Augustine report, I would order them somewhat similarly. I'm a space scientist, and so, of course, I'm going to put space science, or science in general, in fact, from space, at the top of that list. And one of the reasons is because before we send humans to any destination we might choose, we're going to require to send our robotic spacecraft there to understand this destination and determine exactly what it is that humans can do best at that destination.

Because before we send them, we're going to do the science robotically, because it doesn't require the same amount of risk, and it can be done more cost-effectively. But there will come a point where we're going to have a robotic capability, and we would like humans to conduct the investigations.

So I'd pick the science first, and then follow, in second priority, with human space flight. And what derives from the human space flight and the destinations you choose are the technologies you're going to need for both Earth orbit and for getting from Earth orbit to the destination that you're going to. So I agree with Congressman Gordon's assessment of the order of technology here, and that's the way I would list them.

BOEHLERT:

Dr. Koss?

KOSS:

I see nothing wrong with the five recommendations you outlined from the Augustine report. I think the issue has always been the proper balance. I think right now, they are out of balance, in that there is too much emphasis on human space flight and not enough emphasis on the autonomous and remote capabilities. Some of the items may have to be deferred.

I think Dr. Roland made some very good points. He's not advocating the end of human space flight. He's just saying we need to master low-Earth orbit before we can consider more. So, you know, keep all those items in one's mind, but recognize that the balance has to be better struck. And be very careful of mixing the mission of one of those objectives with the other.

I'm a physical scientist. I'm most concerned about mission to planet Earth. And what happened is that mission has got tied in with the human exploration and development of space. And so, there are astronauts involved in physical science experiments, partly to make those experiments easier, and partly for them to gain experience of being on orbit. And so, that mixture, I think, is something to be concerned with.

BOEHLERT:

Dr. Roland?

ROLAND:

I would say that development of launch vehicles is more important than all of the other four combined, because anything we want to do in space entails getting there, whether it's automated spacecraft or human spacecraft. And until we improve our launch vehicle capability, we pay a penalty at the beginning of every mission.

NASA has repeatedly said, and the Department of Defense has repeatedly said, that what is wanted -- they've been saying this for 20 years -- is an order of magnitude reduction in launch cost. And

going along with that is more reliability and more safety in our launch vehicles. That's still true. And if we address that objective, then all of the other things that we want to do in space will become cheaper, easier, and more efficient.

BOEHLERT:

Thank you very much.

For my colleagues, I'm mindful that the red light is on, but I'll have Dr. Murray respond briefly, if he can, to my question, then I'll go to the others.

MURRAY:

Yes. I want to point out that the reason we're having these hearings, or have them taking place now, is human flight, not NASA's total progress. And so, the Augustine report put automated flight well above it in priority. So we now have a human flight situation, which has become a financial, political problem. That's why we need to deal with it.

I think that is not solved by a heavy lift vehicle. My understanding is any heavy lift vehicle that's put together now will have to have multiple applications. You certainly don't need it for automated science, that I know of. I don't know if the Defense Department has special needs for something this huge, which we're talking about, or not.

The reason it's important is -- think this through very carefully -- there's a huge wedge, at the beginning of any program, once you say we have to have this new vehicle. Product improvement of the older ones is great. So I don't believe -- the reason is, for human flights to Mars or to other distant places, on-orbital assembly is an alternative which should have flowed out of the space station development. It has not. But that may be, by far, the more competitive way of doing it.

I want to mention, just finishing up on this, the idea of curtailing human flight. People seem to forget NASA chose to do it itself. Between 1975 to 1981, there were no Americans in orbit because NASA wanted to develop the space shuttle. And so, following Apollo-Soyuz in 1975, there were no astronauts in orbit. They built in that hiatus of six years for a shuttle flight in 1981.

I don't see why that's such an unacceptable alternative in looking at changing the program mix in the current situation -- wouldn't just say we have to do it the way it was imagined to be done in 1983, when the space station was first started.

Thank you.

BOEHLERT:

Mr. Hall?

HALL:

Thank you, Mr. Chairman. I agree with most of the statements.

It's proper that we take some time in the aftermath of a calamity like Columbia to determine the best path forward. And I certainly agree with one of you, whoever said that -- less to look for blame, but to look for how we run a better program, and look to the future.

And the one word that keeps coming to me and coming to me, and one that I never will abandon, is safety, and continue to pursue some safety for whatever vehicle we have. And if we have another such loss, tragedy, and we haven't undergone a venture, a start of that travel toward safety, then I dread to be a member of Congress or to be a member of the NASA team.

I think they'd better damn well get started on getting us some safety in the shuttle itself, and I support the shuttle system. I think we need to move beyond a debate of whether or not we ought to have a human space flight program. There should no longer be a question

of robotic versus human exploration. Clearly, both are going to be needed to explore our solar system.

And Dr. Roland, you've at least been consistent. I don't agree with you, but you've been consistent up to this time, and will probably remain consistent forever. Like a turtle that bites you, he won't let loose until it thunders, I've always heard.

(LAUGHTER)

I want to say that for whatever question I ask, I want you to crank into the computer the escape nodule for the shuttle. That just has to be a part of it. And I don't see how anybody can disagree with that. Dr. Griffin or Dr. Huntress, you've both advocated exploration programs with longtime horizons. Both of you have extensive experience at trying to obtain resources for NASA, and for a lot of the NASA programs, from a Congress that has to focus on annual appropriations, and what we have, and what we can foresee, and what we can afford.

I guess my question is, how would you design your program to survive the inevitable ebb and flow, as we call it, of congressional funds, or of political support, or fiscal support over the time period required to achieve the goals that you propose?

Dr. Griffin, you might answer that. If NASA budgets -- let's just say it should stay flat, at a level of roughly 15 billion for the foreseeable future, could the exploration program that you advocate be successfully carried out, and if so, how?

GRIFFIN:

Thank you, sir.

If NASA's budget were to remain flat, then I think if we want to -- I think we've been doing things that have not been advisable. And if we want to do new things, go in new directions, and at the same

time, keep the budget flat, we would have to, in my view, take ourselves out of a number of commitments that we now have.

These are commitments to international partners on space station, commitments to keep it going in the near term, which implies the use of shuttle, and so forth. I would regret that, because as I indicated in my written testimony, I believe there is value in the United States keeping its word. In the program of the future that I envision, a program of exploration, it would be a program that involves people from all nations, but I see the role of the United States to be the leader among them.

It's very difficult to function as a leader if we do not have a history of keeping our prior commitments. That said, if there is to be no more money available, and if we are to undertake a program to do newer and better things, to make better choices, then there is no possibility other than closing off some of the old avenues and re- vectoring what we do.

HALL:

Dr. Murray?

MURRAY:

I want to emphasize, I think the Mars program...

HALL:

Come a little closer to the mike, if you will.

MURRAY:

Even better if I turn it on.

(LAUGHTER)

MURRAY:

I think one of the defects in the national thinking about going to Mars with humans is it tried to be modeled on Apollo. That's not the right way. Apollo was a one-shot deal, enormous investments over a short time, at a certain period.

MURRAY:

In the case of going to Mars, what counts for us now is that that is an acceptable destination, and we're going there not to show the flag, but to do something that has long-term importance. That means it can be broken up into a set of steps. The steps provide flexibility in the budget aspect, also allowing for unpredictable things in the future.

For example, this whole issue of on-orbital assembly needs to be understood. That may change the launch vehicle requirements significantly. That's a task. Another thing we could start right now is we have a large automated program of exploring Mars scientifically -- a great one, enormous resources going into that very effectively.

There is no formal linking of that program to the fact that we're also thinking we would like to have human landing sites there in the future. We call that the Mars outpost concept, to identify places that, from what we know now, would be suitable for human landing, and to focus Mars automated resources on them, with the idea of implementing communication, data handling, mobility, and maybe even chemical processing of materials in advance, so that by the time we really get ready to go, we know where we're going, and some of the resources are already there.

That cuts down the cargo requirement and ensures a long-term situation. I think there's a long list of these things that we can go through. But that kind of thinking -- how do you break it up into pieces that are interesting (inaudible) each one of which is affordable, is what is lacking so far, and we need your help in putting pressure on the administration and NASA to begin the (inaudible).

HALL:

Dr. Huntress? My time's almost up. It looks mightily like a red light there, but maybe it's just orange.

(LAUGHTER)

I'm colorblind, so I don't know what color it is. But, Mr. Chairman, could I have another, maybe, half a minute?

BOEHLERT:

Sure.

Dr. Huntress?

HUNTRESS:

Well, I tend to agree with Dr. Griffin. I mean, if we keep NASA constant at $15 billion, even assuming that you add inflation into that, that we really have two choices. One is what Dr. Griffin talked about, which is, okay, we need a new vision, and we're on the wrong path, and let's reengineer what we've done. We've got to give up our commitments to our foreign partners. We have to do something other than space station and shuttle.

Or the other path is that we continue business as usual. But that's all that we can afford at the moment. And that's unfortunate because, at some point, we're postponing what the public really wants us to do, and it will have a tendency to perpetuate the current infrastructure. And so, I think we need to really think what path we want to go on and what it's really going to cost.

I do believe that we can put a program together that's progressive, that goes step by step, that doesn't require an Apollo- like spending curve, that would require a minimum increase for the annual budget of NASA over a long period of time. I think that's possible.

HALL:

Thank you.

BOEHLERT:

The gentleman's time has expired.

In your testimony, Dr. Huntress, I put exclamation points after this one sentence of yours -- "There is a growing course of leaders inside and outside of government concerned that NASA's post-Columbia investigation posture is business as usual." Could you expand upon that a little bit? Then, we'll go next to Mr. Smith.

HUNTRESS:

By business as usual, I mean we just continue on our current path. We upgrade the shuttle, we fix the current problem with the shuttle, and complete the station, which, I think, to honor our international commitments, we really must do in the long run. But we need to look beyond the space station. What's going to come beyond that space station?

That's not business as usual, and that's what requires a new vision for what we're going to do in...

BOEHLERT:

Thank you very much.

Mr. Smith?

N. SMITH (?): Thank you, Mr. Chairman. Thank you also for convening this hearing, and also for having such expert witnesses today. I also want to thank Mr. Rohrabacher, who's the subcommittee chair, for allowing me to go ahead of him to ask some questions, because I'm late to another appointment.

Dr. Koss, before I get to a space question, I noticed in the last line of your resume, you say you're a lifelong Red Sox fan, approximately a one hour drive from Fenway...

BOEHLERT:

The gentleman's time is expired.

(LAUGHTER)

N. SMITH (?): I suspect you made a big sacrifice to be here today, because you missed the game last night. Is that correct?

KOSS:

That's correct. But the pilot kept us informed on the airplane. But the crowd didn't cheer until there was at least a three-run lead.

N. SMITH (?): We know where the chairman of the full committee is on this, so we won't pursue the subject anymore.

My question, really, for every witness today is this. It seems to me that we are, in some sense, drifting when it comes to what do we do in space, and when do we do it. We don't have a vision.

Dr. Huntress, you referred to this both in your testimony earlier and in response to a question a while ago. And I think we would benefit by having a specific goal. And my, really, question to you all, each one of you, is if you were advising the president, what would be your recommendation to the president, to announce in a major speech, as to what our goal in space should be over the next five to 10 years?

Dr. Roland, for you, it might well be launch vehicles, developing them. Dr. Huntress, for you, it may well be at least initiating, if not completing, a mission to Mars. But I'd like to just ask each of the witnesses, what would be your advice to the president, either for a

vision or for a goal, as to what we should be doing in space over the next several years?

Dr. Griffin, if you'll go first.

GRIFFIN:

Over the next decade, I would want to see the establishment of a lunar base and the development of the technologies necessary to support that. That includes the heavy lift launch vehicle, space-nuclear power systems, things like that. I would want to see the necessary robotic program undertaken to pave the way for human landings on Mars, very much in keeping with Bruce Murray's Martian outpost concepts.

N. SMITH (?): Thank you.

Dr. Huntress?

HUNTRESS:

Congressman Smith, I hope you will allow me one minor change to the challenge here, because I do believe that a decade is far too short a time scale for having a vision for this country's space program. And so, I would recommend to the president that we establish a goal to establish a permanent human presence in the solar system, with a specific stated objective to establish human presence on Mars by the middle of this century, and that the near-term actions required to do that would require some re-engineering of our current paths in getting to Earth's orbit.

N. SMITH (?): Thank you.

Dr. Koss?

For the record, Dr. Huntress, near term you're talking -- give me an idea?

HUNTRESS:

Ten years, 10 years.

N. SMITH (?): Ten years, thank you.

KOSS:

I think it's premature to have a vision right now. I think the chair correctly pointed out that the vision is blurry. So I think a panel like this, and others, should go on with other witnesses and other discussions to focus that vision. There needs to be a common ground forged. And without forming that common ground, I don't think any vision is appropriate at this point.

N. SMITH (?): Dr. Roland?

ROLAND:

Mr. Smith, as you guessed, I would recommend launch vehicle development, but I would phrase it in terms of access to space. Space has enormous potential for human applications, which we're unable to exploit now, because it's so expensive and dangerous to get there. And if we could open up that access, it would open up countless opportunities.

N. SMITH (?): Thank you, Dr. Roland.

Dr. Murray?

MURRAY:

Thank you.

I would say what we need is a destination, a place that's worth risking human life and a lot of money, that's imaginative and uplifting. And Mars is clearly that. So the president, if he really wanted to achieve the reversal of the decline we're in, would first

have to say that's where we're headed: I commit the United States of America in that direction.

We need that to be international, we need, therefore, to involve others, and we need to take some near-term actions, like the Mars outpost, like setting alternatives to the particular heavy lifts, and so forth. But it would have to have, therefore, some budget request to go with it to make it believable. But it wouldn't have to be a lot.

But I think the very fact that he has declared that would change an awful lot of things, including NASA's own attitude toward itself, which is a major problem here.

N. SMITH (?): Thank you, Dr. Murray. Thank you, Chairman.

BOEHLERT:

Thank you very much.

Mr. Gordon?

GORDON:

Thank you, Mr. Chairman.

As I had mentioned earlier, I want to discuss some of the pros and cons of, as Mr. Griffin pointed out, a lunar outpost. There are some that would say, you know, we've done there, been that -- or done there, done that, and that really isn't a great vision. Chairman pointed out earlier, whether we like it or not -- and I would say most of us on this committee don't like it -- we're not going to have a significant increase in the budget.

And you can talk about us not having vision or not having courage all day long. But the fact of the matter is, we're not going to have a significant increase in budget. Hopefully, we're going to see some increase, so we're going to have to put it in that perspective. And again, I would like to have your thoughts as to the benefits or the

cons of having a lunar outpost, potentially, as we did in Antarctica at one time -- the lessons that can be learned there, and it being a potential kickoff, through those lessons, to maybe a more aggressive vision of going to Mars at a later time.

Mr. Griffin, you started it. Why don't you tell us what you think?

GRIFFIN:

Thank you, sir.

Let me first say that if I implied in my earlier remarks that the vision is to go to the moon, that's absolutely wrong. I agree with Wes, my former NASA colleague, that the vision needs to be much longer term than that, and is really nothing less, as I indicated in my written testimony...

GORDON:

But is the moon on the way to Mars?

GRIFFIN:

The moon is on the way. The vision is nothing less than the permanent human occupation of the solar system. Now, in the next decade or so, the things that we need to do first, my ordering of that might be different from some others. I believe that going to Mars...

GORDON:

Okay, If I could, I've got a short period of time, and I'd like to focus the comments on the pros and cons of a lunar colony.

GRIFFIN:

The pros in support of a lunar base would be that that is where...

GORDON:

... or base.

GRIFFIN:

... that is where you learn how to survive for long periods of time on other planetary surfaces and be only three days away from home when things go wrong, as they inevitably will. The cons are that it's money spent in a direction not as interesting as Mars.

GORDON:

And that's not in the same direction?

GRIFFIN:

I believe they are in the same general direction. But there will be things one needs to do -- return to the moon -- that one would not need to do to go to Mars.

GORDON:

Are there other research values?

GRIFFIN:

I think so. The moon is an extraordinarily interesting place to setup both radio and optical telescopes.

GORDON:

Anybody else like to comment on that, particularly on that topic?

(UNKNOWN)

I'd like to comment that over the many decades that these debates have been going on, the astronomical community has been very cool toward any kind of major facility on the moon. I know, because I tried it one time, to raise interest in that. Almost always, they say

they do much better having them just out in deep space itself, not tied to the moon.

So I think it'd be very difficult to build if that is the case. I think the case for it as a stepping stone to Mars has some merit. But to the extent that it's, financially, a significant diversion, I don't think that will fly. I think that if...

GORDON:

I don't...

(UNKNOWN)

Go ahead.

GORDON:

I mean, it just seems to me that if we're going to go to Mars in 30 or 40 years, or whatever it might be, that we may want to show a little something for it on the way, so the taxpayers might have the courage to continue to pay the bill.

Let me ask, what's going to happen if China decides that they're going to have a 10-year goal to go to the moon and set up a base -- not a base, but an outpost, or a base, excuse me -- or Russia says in 15 years, are we going to say, "Good luck," or are we going to try to catch up at that time?

ROLAND:

My suggestion is we could sell them the space station.

(LAUGHTER)

ROLAND:

That's an option for us now, because we are at a point where supporting the space station really...

GORDON:

Okay, I don't want to get into that. I want to talk about the moon, or not. You know, I've got a limited amount of time, so please put your remarks on...

ROLAND:

No, but my whole point is to get into low-Earth orbit is how we can do anything in space, whether it's the moon, or Mars, or any of our scientific experiments, and that's what we need to concentrate on. It will make all the...

GORDON:

(inaudible) message, but I've got a short period of time. Would anybody else want to comment on the pros and cons about going to the moon?

(UNKNOWN)

Yes, Congressman Gordon.

I think the moon is sort of an off-ramp on our way to Mars. And there are some useful things to do there; there's some good scientific work that needs to be done there. Europe, Japan, China, are all interested in Mars, because they've never been there, and so they tend to focus on that.

And so, the only thing I worry about is that if we design a system to go to the moon, that's all it will be able to do. We need to design a system that can go to Mars, and use it to go to the moon to do whatever we need to do to enable Mars exploration.

GORDON:

Anybody else want to say something, then I'll...

(UNKNOWN)

Yes, I want to challenge the presumption that because China got its first astronaut, or cosmonaut, or taikonaut, or whatever it is, in space yesterday, that this leads immediately to a very big expansion. It's 40 years after this was done by the U.S. and the Soviet Union. I'm surprised it hasn't been done by Europe and by Japan on the way, who could have easily had the technical -- and the reason was, it wasn't that important.

The reason it's important in China is, obviously, political, both domestically, and especially in Asia, I think, which is fine. I'm glad they've done it. But we shouldn't necessarily extrapolate from that that they're going to repeat...

GORDON:

No -- you know, the hypothesis was that they said they were going to do this in 10 or 12 years, would we not challenge that?

(UNKNOWN)

We've done all that. We did that long ago. We've got to do new things that win people's admiration, both our populace and the others. To go back and get drawn into 30 years ago rivalries is crazy.

GORDON:

I think there's a difference between going to the moon, touching base, and going home than setting up an outpost. Did you -- yes, sir.

(UNKNOWN)

Returning to the moon may have some small advantages, requiring physical scientists to be enabling technologies. But in terms of a location for the physical sciences to benefit, it has nothing to offer.

GORDON:

Thank you for your laxity there, Mr. Chairman.

BOEHLERT:

Thank you very much, sir. I'd to do this, but I will -- a quick yes or no: the value of the investment, is it worth it to talk in terms of an outpost on the moon?

Dr. Griffin?

GRIFFIN:

Yes.

BOEHLERT:

Dr. Huntress?

HUNTRESS:

Yes.

BOEHLERT:

Dr. Koss?

KOSS:

I don't know.

BOEHLERT:

Dr. Roland?

ROLAND:

No.

BOEHLERT:

Dr. Murray?

MURRAY:

No.

BOEHLERT:

Boy, there's a divided panel.

(LAUGHTER)

(LAUGHTER)

BOEHLERT:

Two to two, and one abstained. Thank you very much.

You've got clear direction there, Mr. Gordon.

The distinguished chairman of the Subcommittee on Space, Mr. Rohrabacher -- better known as the governor-elect's friend.

ROHRABACHER:

Did you get that blurry picture more in focus for us...

(LAUGHTER)

... my gosh. Mr. Roland, you, of course, remind me of Robert Heinlein's famous saying: "Once you're into low-Earth orbit, you're halfway to anywhere else in the universe."

ROLAND:

Right.

ROHRABACHER:

So whatever our goals, whatever we talk about today, Mr. Chairman, having been on this subcommittee and spent this time looking at this issue, and having been in the White House prior to that and looking at space issues, that truism hasn't changed all these years. I think Robert Heinlein must have written that 25 years ago.

So does anyone on the panel disagree with that? No. So Mr. Chairman, it's clear -- excuse me, I've got a cold, obviously -- what's clear, then, is that whatever goals we set, the first step is what? Is finding a way to get into low-Earth orbit at a cheaper rate.

So I have been -- let me ask this question to the panel. All of you, it seems, except, perhaps, Mr. Roland, would like an increase in the budget of NASA as we have it today, rather than having a flat budget, and have a more visionary program. At what level do you want that? Mr. Huntress didn't exactly tell us exactly how much that was. How much would you suggest, and would you support that funding coming out of other programs that are being financed by the United States government in terms of science research in American universities?

That will tell you whether you really believe in it or not. Mr. Griffin first, and then...

GRIFFIN:

I indicated in my written testimony that I thought the right target level to allocate to NASA, on a steady basis, was around $20 billion.

ROHRABACHER:

Plus $5 billion more a year...

GRIFFIN:

About $5 billion more a year. That's actually because I don't think we should have a big, Apollo-style ramp-up, and all that that entails.

ROHRABACHER:

But do you believe that you would accept that that money would be coming out of the research project money for major universities -- that would be worthwhile, taking money from science research in our major universities and putting it there, $5 billion a year?

GRIFFIN:

I don't know that that's where I would take it from, but...

ROHRABACHER:

No, no, but this is an answer that you know about. The other places that you might not take it from, you might not know about -- everybody can take it from places they don't know about. So is it more worthwhile to do it that way?

GRIFFIN:

If that's the way it had to be, then that's the way it would have to be.

ROHRABACHER:

Dr. Huntress?

HUNTRESS:

I agree with Dr. Griffin on the amount that would be necessary, about an extra $5 billion a year. And one can lead up to that; you don't have to add it all at once.

ROHRABACHER:

Right. You believe in it enough to take it from other university research projects?

HUNTRESS:

And I believe it needs to be an additional component to what this country does in exploration. You've targeted one area, which is scientific research, and I would not take it from there, no.

ROHRABACHER:

Okay, so your answer is you don't believe it should be $5 billion more a year if it has to come from something you know about.

HUNTRESS:

I don't think it should be an extra $5 billion a year if it comes from this nation's scientific research fund.

ROHRABACHER:

Okay, there you go. You don't believe it, then.

Yes?

KOSS:

Obviously, I have a university research bias.

ROHRABACHER:

Yes.

KOSS:

I certainly don't believe the money should come from university science research funds. In addition, I don't think it's healthy for the scientists on that...

ROHRABACHER:

Okay, so you don't believe it either.

Mr. Roland?

ROLAND:

The United States spends more on space than all the rest of the world combined. We spend plenty of money on space. The whole question is the pace of what we're going to do, and I think we can hold the budget steady and achieve our goals, perhaps, over a longer term.

ROHRABACHER:

Okay, there you go.

Yes?

MURRAY:

That's a very good question, and you're getting to the heart of it. I think the problem is we're spending $7 billion a year, presently, on human space flight, without adequate return. I think we should restructure that program with an idea of diverting some of those funds to longer-term things.

ROHRABACHER:

All right, that's how I've learned, in my tenure in office, to find out if somebody really believes in the spending proposals they're making, is to ask them to juxtapose it to something else they think is of value. And I would suggest -- you know, no one's here to hear my suggestions today, but let me ask about just one question about propulsion.

And I do believe, as I say, that propulsion is the most important issue to get us wherever else we want to go. Will nuclear powered engines, and the development of this, help us to get to that low-Earth orbit, or is that just while you're in space -- just a very quick answer all the way down the line?

GRIFFIN:

Space nuclear propulsion is intended for in-space use.

ROHRABACHER:

But you don't see any use to get us to low-Earth orbit.

GRIFFIN:

I do not, in the near future. There might one day be a way.

ROHRABACHER:

Okay.

Mr. Huntress, do you see anything in that?

HUNTRESS:

No, I agree that nuclear propulsion is the right way to go for in-space propulsion, but not for...

ROHRABACHER:

Okay.

Mr. Koss?

KOSS:

I can't answer. I'm not a rocket scientist.

ROHRABACHER:

All right.

Mr. Roland?

ROLAND:

I don't have the technical competence, but I'd be worried about the public relations and safety issues.

ROHRABACHER:

What about the technical end of it? Is there a potential...

ROLAND:

I'm not technically qualified...

(UNKNOWN)

I think the reason is that nuclear propulsion translates into relatively low thrust...

ROHRABACHER:

Right.

(UNKNOWN)

... which is best...

ROHRABACHER:

I've heard some ideas recently that indicated that there might be some other way to do that. All right, well, thank you all very much, and thank you (inaudible) first of all, I want to thank the chairman for calling this hearing. And we need this discussion, and I thank you very much for putting together such a distinguished panel for us to base our future considerations on.

BOEHLERT:

Thank you very much, Mr. Rohrabacher.

The chair recognizes Mr. Lampson.

LAMPSON:

Thank you, Mr. Chairman.

Monday, we celebrated Columbus Day. Five hundred eleven years ago, Christopher Columbus traveled those uncharted waters across what we now know as the Atlantic. I wanted to comment on Dr. Roland's comment -- and I'm not asking a question right now.

It would be interesting to know the number of lives that were lost per boat as they came across -- and wonder if that would have been considered by Amerigo Vespucci as to whether or not he should follow in that path. That's something worth our consideration. Anytime we do exploration, there's going to be some risk. I pray that we never get to a point where we fear the loss of some life to what we might gain in the future for overall life.

I also want to welcome China into the space flight club. I think it's great that they have done what they have done. I think it continues to increase the knowledge and awareness of our involvement in space worldwide. History has shown that great nations explore. The United States must not turn its back on human space exploration at this critical time.

We must return the space shuttle to flight and complete construction of the International Space Station. At the same time, this administration and this Congress must provide the American people with a vision and a concrete set of goals for the nation's future human space flight program. It's clear that China has set goals, or has goals that have been set by its leadership, and we need the same.

And with that being said, I'd like to ask both Dr. Griffin and Huntress if you're familiar with the Space Exploration Act that has been introduced both in the previous session and in this year. And if you are, would you please make some comments about it as to how it

fits in with accomplishing just those things, the goals that we need to have, and what we can get back in our involvement in space?

GRIFFIN:

Yes, sir, I did read it -- not within the last few weeks, so I don't recall all the details. But I thought it was very good. I was very much in support of it. It is in the direction that I personally believe we should go. The only thing I would like to see is a little bit more of an effort to set specific time horizons with the funding required to implement them.

LAMPSON:

Let me ask this: do you consider it to be micromanaging of NASA?

GRIFFIN:

Possibly, a little, but then again, it may well be that that's needed in order to get going in paths different from where we are.

LAMPSON:

Thanks.

Dr. Huntress?

HUNTRESS:

First of all, I think a bill like this is very important, because what it does is to get the sense of the Congress, as representatives of the public, squarely on the record as to what it believes this nation's space program ought to really do. And something like this should be a bipartisan clarion call for this country's space program.

I find a lot in this bill that I really like. I support it because it's, frankly, consistent with the kinds of future vision, you know, that I've been thinking about for the last several years. It speaks about a

commitment for a future for human space flight. It talks about both human and robotic means to do that. It identifies Mars as the ultimate goal, but with a stepping stone approach, for a very progressive and more affordable program. It talks about scientific exploration as the basis for it -- something that we need for inspiration to our youth.

If I were to try to find some criticism, it would be that I think the time scales are, perhaps, a bit proscriptive, as well as some of the processes that it talks about for the administration.

LAMPSON:

Congressman Smith asked a while ago about advice for the president. Would this be reasonable advice for the Congress to be able to take these kinds of steps, and would that energize our nation enough, perhaps this government enough, to find the kind of attention or statement that he may be looking for, a while ago, for the president?

GRIFFIN:

Anyone?

LAMPSON:

Either of you two, particularly.

GRIFFIN:

I think the language is a bit -- I would say it's one level down in the onion below what is appropriate for a national vision, especially coming from the chief executive, or as a, you know, bipartisan consensus from the Congress. I think the level of detail is, again, as Wes said, I largely agree with what's there, but it needs to be at a little bit higher level to be captured, I think, as a national vision that's understandable and supportable by law.

LAMPSON:

And then, let me ask this about what happens -- both of you have advocated, obviously, a space exploration program over the long-term horizons and all. How would you design your program to survive the inevitable ebb and flow in political support over the time period required to achieve the goals that you propose? And that's part of what I think our problem is now. That has changed, clearly, through administrations in the last many years.

Your thoughts?

HUNTRESS:

I think the way you do this is by designing a program that's a little bit more immune to that than the one we have now. And the way you do that is by having intermediate destinations, a progressive approach in which you build the infrastructure slowly and more progressively, instead of all at once, so that you can adjust the time it takes to construct that infrastructure, depending upon the annual budget process.

LAMPSON:

Thank you all. And Mr. Chairman, I would ask that all of my colleagues give consideration to the Space Exploration Act. It may be much in the direction to achieve what we have had as discussion this morning, and I thank you very much.

I yield back my time.

N. SMITH: The gentleman's time has expired.

The chair asked me to take over, because I have the next question anyway. I always hate to be a wet blanket, because I like to be an optimist. I'm really dismayed by some of the optimism I see here. I think there are a lot of problems that have been glossed over, and we should take a look at those.

First of all, one thing I gathered from this is most of you regard the space station as not particularly useful for our long-term objectives, and some of you said we shouldn't have done it at all, that it was hindering our efforts. Perhaps, we ought to rename it the albatross, because it's up there, we have to take care of it, we have to send crews back and forth, and that's going to consume a lot of our resources.

But if our long-term goal is interplanetary exploration, it may not be that helpful. I may be overstating it, but I want to get on to the other issues. The discussion of going to Mars, on which the panel is precisely, equally divided -- Dr. Griffin, for example, you said your goal, you believe, or our goal should be a human settlement of the solar system and beyond. Let me just comment a bit on the comparisons we've had to Columbus.

I don't think it's a good analogy at all, frankly. First of all, Columbus was not a scientist. He was trying to make money by finding a shorter trade route. And if he were much of a scientist, he would have known that the diameter of the Earth had been calculated some time before, and the distance he preferred to travel was far too short. However, he was lucky, as many scientists are, and quite a few businessmen, and he stumbled across something that was even better than what he had expected, or what he was looking for.

The settlement of what we now call the West is far different than settlement of planets, because we have a huge number of resources here, better resources, in fact, than the country from which they came -- little life support was needed, other than the food, to transport them across. They didn't need energy to get here; they used the wind's energy.

I transfer to Mars -- I understand, you know what's involved, but the general public thinks that we went to the moon, and the next step to Mars. The moon is just a stone's throw away compared to Mars -- it's a very, very long trip. And I, personally, don't think we're going to get there without, first of all, considerably better sources of energy,

far, far better sources of propulsion, and a method of induced hibernation for humans, unless we want to try -- it might actually be easier to make bears, frogs, and other things that hibernate into intelligent beings than it would be to make humans into something that could hibernate.

But the energy involved in transporting individuals in interplanetary travel is immense, and the human subsistence requirements are immense. You combine the two, and it's a very long, very expensive, very difficult journey. I'm not saying it can't be done. But I would also say that I don't think it's ever going to be done without international effort, because I can tell you the public is not willing to spend that amount of money to put one person on Mars, unless there is a substantial return involved.

Internationally, I think we could put together the forces to do it, if we can cooperate. So I'd be very interested in any comments that you would like to make about that pessimistic view. I'm not saying we shouldn't explore space; I think we should. But placing a human being on Mars, I think, might be as much of a limiting factor for our efforts to explore space as having the space station up there now is limiting our efforts to go beyond, and do experiments out of Earth orbit.

So we've always been going that way; let's switch the other way around. Dr. Murray?

MURRAY:

Thank you.

In terms of propulsion to get to Mars, when we send an automated probe, it takes very little energy beyond getting into orbit, getting into high orbit, to go to Mars, or Venus, or the moon. It's not much; it's coasting most of the way. You have to choose the right time to go so it's an easy coast.

So I don't see that as a showstopper itself. It is true that the regenerative...

N. SMITH: May I just interject to clarify?

MURRAY:

Yes.

N. SMITH: I'm referring not so much to the energy to get there, but the amount of energy, potentially, you have to take along to get to the surface of Mars and to get back off the surface, and get started on the trip back home.

MURRAY:

Mars is the one planet that has carbon, hydrogen, oxygen, and nitrogen easily available. Greenhouses can work. There's solar energy, although, presumably, some nuclear power would be available in the future. It's the one place you can go where you can grow food. It's the one place you can go, take some of that ice we found, break it up and make hydrogen and oxygen for propulsion systems to come back.

That's the kind of thinking that's been going on over this long hiatus of exploration. So I think that what's lacking is that we haven't had an effort, under government sponsorship, to really look at how you could do this, other than the Apollo way. I think that it is difficult, or that this is formidable, as you extrapolate from the Apollo experience.

It does take breaking the pieces, as Wes has said. It does take believing in that goal. I mean, if that's not, you know, the goal, then it's not going to happen. But I don't think it's that. I don't think it has to cost a bundle if we do it in modules in time. I think it would be popular if it's done the right way. But we've not had a chance to develop and put forth before you a program like that.

N. SMITH: Dr. Roland?

ROLAND:

I've seen estimates of hundreds of billions of dollars just to send one mission of humans there, and that's not to build-up an infrastructure on Mars and start to colonize it, and build a base where you can begin to exploit growing food and processing fuel out of there. So I think the cost would be enormous. And it begs the question of, what would a human outpost on Mars return on that investment?

N. SMITH: Dr. Koss?

KOSS:

I think your assessment is correct. And as much as I'm a fan of a larger mission for NASA, I'd hate to see a single mission rob the other missions that NASA does, that only NASA can do. And I speak most particularly to the field that I work in, in the laboratory sciences on-orbit. And on a side note, I might mention that your Columbus analogy, it's been speculated that Columbus knew the size of the Earth, but he misrepresented it to get better funding.

(LAUGHTER)

N. SMITH: Which shows he wasn't really a scientist, because a scientist would never do that.

Dr. Huntress?

HUNTRESS:

First of all, I agree this should, and must, be an international enterprise. I agree that no one single country is likely to be able to afford such a venture, and it should be international not just on budget reasons, but for good human reasons and societal reasons as well.

The hundreds of billions of dollars that Dr. Roland quoted is the 1989 number for a program designed by NASA to be done in the Apollo style, and that's certainly not the way that we should do it, and probably won't do it that way. It will take much less if it were done in a progressive way. And I agree with Dr. Murray that the way to do it is using "in situ" resources.

What I would envision is sending humans there quickly and fast on chemically propelled systems, sending their cargoes separately on efficient electric propelled systems, and using "in situ" resources on the surface of Mars to create the resources they need on the planet, and to prepare fuel for their return.

N. SMITH: Dr. Griffin?

GRIFFIN:

I agree wholeheartedly with the technical comments Wes made on the approach to doing the mission. I would point out that if we had project managers who think that it takes hundreds of billions of dollars to go to Mars, then we need to get new project managers, not a new destination.

With the nuclear upper stage that we, the United States, had -- we owned a space qualifiable nuclear upper stage 30 years ago, and terminated the program because we were not, at that time, going to Mars. Transit times would have been two to three months. That is well within, even doing it in that mode, the experience base that we have for space flight.

So I just do not agree that hibernation is required or that it's particularly difficult to do that. And again, I would probably not put the crew in zero-G if I were going to do it. I would use spinning spacecraft. And again, I can only echo Dr. Huntress and Dr. Murray that when we go to Mars, the plan for doing it should be one that utilizes, to the maximum extent, pre-placement of the hardware

needed to sustain people, use of the Martian resources that we already know are there.

We should do the program intelligently. I think that can be done. One can find ways to waste as much money as you would like to do. I think we can do better than that.

N. SMITH: I appreciate the responses. I was trying to be somewhat provocative, and I think I succeeded. But I think everyone should realize what a major, major step this is -- far greater than anything we have ever done as a nation. And I just warn you, politically, it's going to be very, very difficult to get that support, even within the scientific community, many of whose members will react the way they did to the SSC thing.

For the amount you're spending on that, we can do 10,000 experiments in the life sciences that will be more important. So the real difficulty, I think, is politically, unless it is very long term, and, in fact, you do develop much better methods of transportation and propulsion, and have a very well thought out plan for doing it.

You've all heard the bells. We are very Pavlovian in the Congress. The bells ring, we vote. We have three votes, which means it will be at least a half-hour, and we will have to recess at this point. And I assume others have questions -- Okay, we'll try to get through one more questioner, and then we'll go vote. And there should be sufficient time for you to run downstairs and get some lunch while we go vote. And we will be back as soon as possible after the third vote.

I'm pleased to recognize the gentleman, Mr. Bell, Congressman Bell.

BELL:

Thank you, Mr. Chairman.

I wanted to explore the subject, if I could, of robotics that several of you commented on during the course of your testimony. First of all, Dr. Huntress, you pointed out that you can run out of robotic capability. And if you could just explain how that would occur, I'd like to hear your explanation.

HUNTRESS:

Well, you know, first of all, the advantage of robots is that they're inherently expendable. You can use them where humans are unacceptable, the risks to humans are unacceptable. The problem with robotics is that the methods of remote control for these robotic systems are often cumbersome and delayed, and so we should use them where there's no clear advantage for human beings.

And the advantage, however, that humans have is humans are ideally suited to tasks that require very complex physical articulation, expert knowledge, judgment, and versatility, kind of like in the Hubble space telescope servicing missions. And they're ideally suited for intensive field study, like geologists, you know, where you need real time interpretive observation, hypothesizing, testing in real time, synthesizing, reconstruction, like in the geological investigations with Apollo 17.

So there's a role for both, and you have to figure out where that line is on an intelligent basis.

BELL:

And I guess the problem I have is that when this conversation begins, a lot of times, people want to talk about it in mutually exclusive terms, that you either choose robotics or you choose manned space flight, but you really can't have both. And I take it from what you're saying, you definitely believe we need both.

HUNTRESS:

Absolutely. In fact, it never has been one or the other. The Apollo program was heavily supported by robotic missions prior to sending a man to the moon.

BELL:

And let me follow up on that with you, Dr. Koss, because you talked about your fear that the culture of NASA, perhaps, led to some of the problems, and certainly, that's been commented on, and while you were there, you, perhaps, added to that by not stressing the need for robotics. But the robotics program has always been a focal point of NASA, has it not?

KOSS:

Yes, quite obviously.

BELL:

And so, are suggesting now that you think we should have mutual exclusivity, that we should solely focus on robotics and move completely away from manned space flight because of the dangers involved?

KOSS:

No, I think Dr. Huntress has it right. We need a balance. I guess we may differ -- I'm not sure, we haven't spoken about it enough -- but I think I'm looking for that balance to be more automated, remote, and robotic. And I find a lot of the science missions that were headed toward the space station were going to be autonomous operating experiments, but they were going to have to have human-enabled capability to actually be moved from the space shuttle to the space station.

But they weren't going to have humans involved in their operation. And so, that's sort of a silly use of human capability, and so I think I want to eliminate the silly and unnecessary uses.

BELL:

But not eliminate it altogether.

KOSS:

Not eliminate it. Eliminate it where it's absolutely not needed.

BELL:

All right. Well, I just wanted to clarify that, because I think it's important for the basis of the discussion going forward.

And Dr. Roland, your fear seems to be that -- you talked about returning to business as usual. And I'm curious -- and I would assume you've had an opportunity to look at the CAIB report -- and if the recommendations made in that report are followed, then wouldn't you agree that it won't be business as usual?

ROLAND:

If they are entirely followed, I think there's a possibility that that's right. But remember that they're attempting to do the same thing that the Rogers Commission did. And my concern is, what is really required is what everyone's speaking of: a change in NASA culture, and that NASA revealed that its culture was unchanged in its response to the investigation. In other words, even before the investigation had reported, it was establishing a date when it was going to resume shuttle flight operations.

It suggests that it used the accident and the resulting reforms as just impediments to getting back to the same thing it was doing before. That's what was alarming to me.

BELL:

And did I understand your testimony correctly, that you really do believe that we should move almost completely away from manned space flight?

ROLAND:

Until we have a better launch vehicle, because then we can put people in space more safely and far more economically than now. It's a cost issue. For example, on what you were asking about space science, if you give me the same budget and say, "I want to do this science," I'm going to get much better science, much more science out of automated spacecraft than anyone can get out of a manned mission, even though the astronaut, "in situ," adds some marginal advantage, I can send four or five probes for the cost of one manned probe, and I can just do many more things.

BELL:

My time has expired.

BOEHLERT:

Thank you very much. Here's the situation. We'll recess for a half-hour, and we've got a couple more votes over there, and we'll be back. And I'm sorry to inconvenience you, but it's the way of life here on Capitol Hill. We're subject to the bell.

(RECESS)

BOEHLERT:

Just let me explain what's happening. And this is frequently the case when we're interrupted with unplanned activity on the floor and a series of votes, as we've just had. Then, other members, their schedules get all screwed up, and they've got four other things they have to go to. Thus, you get fewer back for the second round, or we haven't even completed the first round.

But we're going to continue, and members will come in and out, and you understand the whole system.

Dr. Gingrey?

GINGREY:

Mr. Chairman, thank you. And I agree, there are a lot of other things pressing, and things I need to be at, but I definitely wanted to come back and ask my question.

As a physician member of the committee, I'm particularly interested in this question. It's a multifaceted, multipart question, and anybody that can respond to it, I would appreciate it.

Given the debilitating effect of zero gravity on human physiology -- bone loss and muscle loss, et cetera -- are long-term manned space missions, and are we close to understanding or creating technologies for life support that would make a long-term manned space mission feasible? What evidence or data do we have that the human physiology problems encountered on long duration space missions, such as Mars, can be solved?

And how long do you estimate it will take to fully understand what is required for long duration human space flight missions to destinations such as Mars? Have we learned anything from the space station? Is that the only place where we can get the information that we need in this area? I know that's a lot, but you get my drift, and again, any one of the five, maybe all of you, could respond to that. I would appreciate it.

HUNTRESS:

Well, maybe I'll try first, Congressman Gingrey.

The space station, in my mind, the utility of the space station is rather singular, and that is to learn how humans can live and work in

space for these long duration trips. That's, in my view, the real value of the space station, and almost for nothing else.

Can we do these flights? I think so. In long-term flights, there's only really two risks: they are radiation hazard from solar outbursts and the debilitating effects of low gravity. This latter one can be readily taken care of by providing a little spin to the spacecraft and eliminating that effect. It might be a little expensive, costs en masse, to do that, but that may ultimately end up being the way to do it if we don't find ways on the space station that don't require spending.

The radiation hazard is the harder one to solve, because it requires some kind of shielding, which I'm sure can be addressed in some way. I don't see any stone wall in our way to these long-term space flights.

GRIFFIN:

I agree with Wes. And I would add the additional comment that zero-G is not really the issue. First of all, there is anecdotal evidence to suggest that more recent crews have sort of learned how to minimize the bone loss by proper amounts of exercise and being very diligent with it, and there may be other kinds of measures.

Even if those don't come true, as was pointed out a couple times today, spinning the spacecraft on the way to Mars, or wherever, is a countermeasure for zero-G. The interesting question that we have is, how does the body perform in fractional-G? Because when you get to Mars, you're going to have to live there for, presumably, extended periods of time, in one-third-G.

The question which has not been settled, cannot be settle on the space station, and is of interest, is what is the body's long-term adaptation to a fractional amount of the G?

GINGREY:

Dr. Griffin, excuse me for interrupting, but I think, basically, that is my question -- that is the question, not just zero- G, but fractional-G over a long period of time.

GRIFFIN:

We don't know the answer, and we don't have a practical way to know the answer until we go and try it out. I mean, I cannot think of a good way to put crews in a one-sixth or a one-third-G environment that doesn't involve going to the planet where those things are.

GINGREY:

Dr. Murray?

MURRAY:

I think we have to remember, unlike what we've been doing in low-Earth orbit, this is exploration, like Apollo was. There are many risks, not all of which can be analyzed to death in advance. The one you mentioned, which is, what's the effect of one-third-G, is certainly a risk of disorientation. It probably has to allow a fair amount of time to adapt on the surface, but it's not nearly as high as the risk of just trying to land there in the first place, I mean, if you look at it rationally.

And so, I think we've got to get away from this sort of shuttle era mentality -- is to make it routine and all that. In fact, we want to go back to exploration, and of course, that's going to entail some risks. The Russians did fly cosmonauts 300 to 400 days several times successfully on Mir. They didn't do as much control by medicine as we would like, but they did. It worked.

And so, I think this is not nearly so unknown as some of the other things we have to deal with.

GINGREY:

Dr. Koss?

KOSS:

The issue you raised about how human beings do on-orbit, or in apparent weightlessness, is important enough that I really, in my statements and what I tried to testify to, is be very clear that I said that it's all physical science experiments are all experiments, save those on human subjects -- probably no substitute for having a human subject in that condition to understand what that does. And so that, obviously, can't be automated. But all the other physical science experiments can be.

GINGREY:

Dr. Roland, did you...

ROLAND:

I don't have much to add, because it's outside my technical competence. But I lose track of what the purpose of a Mars mission is. If it's just exploration to find out about Mars, we're better off sending automated spacecraft. If it's to establish a human outpost there, then your question is pertinent, and we need to address it.

GINGREY:

Dr. Murray?

MURRAY:

I feel that issue warrants a little more discussion. The purpose of sending humans to Mars is not to do science -- never should be. I mean, the purpose is to find out whether humans can operate in Mars effectively, and whether that's something that really sets a pattern for what the future might hold. So learning about that's one of many things.

There's a lot of dust on Mars. There's a lot of other things about Mars we don't know, and the way to find out is to go there. That should be the mission objective. That's the whole point of it, which is not a kind of thinking we've been having, and I think that's the answer to your question.

GINGREY:

I see my time has expired. Mr. Chairman, thank you for allowing me...

BOEHLERT:

Thank you very much, Dr. Gingrey.

Ms. Jackson Lee?

JACKSON LEE:

Thank you very much, Mr. Chairman. This is a vital and very important hearing, and I wish -- my preference would be if we're all sitting around a round table with policymakers, members of Congress, and those of you who are experts, whether pro or con, and really seriously addressing what I think is a question of choices.

Right now, on the floor of the House, we're debating $87 billion in an emergency supplemental that is larger than any supplemental we've ever had in the history of this nation. We have decided to make a choice with respect to that position. And so, in the backdrop of this hearing, we will be debating as well as making a final decision.

If I had my druthers, I'd like to narrow that request down to a finite number that addresses the question of the needs of our troops, and begin to look at the other needs of this nation. Frankly, I believe that there are many, many elements to this discussion about human space flight, and I add my support to Congressman Lampson's proposed legislation on space exploration.

JACKSON LEE:

One thing that I've noted about America is that when we face diversity, we are committed not to run and tuck our tails, if you will. We have faced diversity with the Challenger and Columbia seven. But I don't think this is the time for us to retract on what I find to have a great deal of value, and let me just share some anecdotal points with you.

If Sir Isaac Newton had not been under an apple tree and seen the apple fall, would we have had a theory of gravity in the way that we have it? Charles Darwin, if he had not gone to the islands, would we have understood or at least been competitive on the question of evolution? And if young scientists had not walked through forests, or swam in the water, or thrown a rock, or yelled from a canyon, would we have had knowledge about botany, and oceanography, or physics?

And so, I think there are many questions that we need to address, and I do want to give credence to some of the thoughts that have been raised about whether or not we're getting the kind of return on our investment, both in human space flight as well as the space station. But let me lay out the atmosphere from which two very valiant astronauts are working.

They're two-man teams. They have to perform all of the jobs of astronauts, engineers, physicians, communications specialists, and then they have to breathe deep and exercise. It's no wonder that we have a diminishing of scientific discovery. They are required to be jack of all trades, and they cannot send specialists -- or we have not seen specialist research scientists who might make a difference.

Right now, I think the key is that we're learning to be in space and that there is value for the human space flight from that very perspective. So if I might, I'd like to raise these questions to Dr. Griffin and Dr. Huntress, and then I'll pose them to individuals who represent a different perspective.

Over a period of time, what type of increase we'd have to see to be responsible in human space flight? Secondarily, aren't we seeing a decrease in our own skills ability, from students securing Ph.D.s in physics, and chemistry, and biology, sciences and math? And when we take the bar and lower it, and don't give a challenge of human space flight opportunities to do research beyond the box, aren't we decreasing the sparkle in the eye and the creativity that is necessary to be on the cutting edge?

Frankly, if I put my bias hat on, there's no way that I'm going to support opposing human space flight when my good friends in China have just put a man into space. There's a certain competitive edge that I believe we cannot give up on. Lastly, what is the value of understanding human capacity in space, and should we ever give that up?

Dr. Griffin, Dr. Huntress?

GRIFFIN:

Thank you.

Yes, it is a fact that native U.S. enrollment in institutions of graduate learning is down. Fewer U.S. Ph.D.s are being granted than was formerly the case.

JACKSON LEE:

In the sciences.

GRIFFIN:

In the sciences. And certainly, I think that a collateral benefit of an enhanced human exploration program would be to help reverse that trend. I don't offer it as a reason for so doing, but I think it would be a collateral benefit. I too share your competitive edge, although that's an aspect of my personality that not everyone enjoys. And I

too worry about a national posture, which does not want the United States to be the acknowledged leader in space exploration.

Cooperation is great, but there still needs to be leaders, and I think that should be our posture. Finally, how much would be a responsible amount? I didn't just wing this -- after considerable thought, I really felt that about a 30 percent increase from where we are, not necessarily in the first year, but allocated as a continuing amount, would allow us to gracefully exit the current road that we're on and get onto a road that we like better.

As others have said, the current budget contains enough to do the new things or different things that we want to do. The problem is that you would have to bring to a disorderly conclusion things to which we have had 20 years worth of commitments, and as an American, I dislike doing that. It's not that I endorse those previous things. In fact, I have a very, very long record of not supporting shuttle and station as programs. It's just that I think we look poor in the international community if we bring them to an abrupt halt rather than terminate them gradually.

Thank you.

JACKSON LEE:

Dr. Huntress?

HUNTRESS:

Yes, I agree 100 percent with Dr. Griffin. The problem is not human space flight: the problem is this kind of human space flight. And I'm a Sputnik kid. You know, I grew up, and I was in junior high school when that happened. And I remember those days and what it did to inspire kids of my age, kids who normally have kind of gone past the interest in science and math, but just rekindled everything.

And it created the greatest rush into colleges in the history of this country in science and math. Now, we don't have to have Apollo to

do that again, but we have to have a program which is inspiring to our youth. And we've got what it takes, but we're not doing it right.

So I think that a reinvigorated program with a clear understanding of the destination, of what the game is and where we're going to go will bring people into the stadium. And as far as competition versus cooperation, there always has to be a balance between this. I mean, the Chinese feat, they should be well congratulated. They're now part of this exclusive club, and there's a sense of competition there. And we need to lead this balance of competition versus cooperation by being the leader. That's how one does that.

You lead, and that charges your competitive juices at the same time that you're cooperating and doing what we need to do.

BOEHLERT:

The chair would call on the gentleman from Missouri, Mr. Akin.

AKIN:

Thank you, Mr. Chairman. You've given me the longest lunch break I've had in a week, I think. I enjoyed that. And I've been fascinated by the discussion this morning, gentlemen.

The one aspect that I haven't heard developed -- and, perhaps, it's the most interesting -- you made reference to the writings on the wall behind us, the concept of the vision. And I think a little bit about a couple of the people that I've done some reading on since I've been a little bit older and educated -- one was Columbus, and why it was that he wanted to go around the world.

And essentially, he spent years of his life trying to sell this idea, but his basic idea was he just wanted to go around the world the other way. And then, you have Lewis and Clark and their expedition, a little bit more practical about what was going on. And then, not too long ago, this committee went to the South Pole. And on the long plane ride down there, we had some time to read about Scott and

Shackleton, and some of the challenges of the Norwegians to the British explorers and their different sort of attitudes toward exploration.

But just the Northwest Passage and then the South Pole, these were all things that, from a practical point of view, these explorers had to come up with some sort of logical excuse to want to do something, which really, in their heart, they just wanted to do because they wanted to do it, not so much because they had to be so practical about it.

So I guess it seems to me that there's a little bit of a pattern. There's something in human nature that's a little kid that wants to dream and wants to go out and reach out, and do something that's not been done before. And I think that's something we ought to acknowledge. And I think you were, Dr. Huntress, you were talking about, you know, the Sputnik era.

That's, I think, what we're looking for, is a way to explain that, some way to say, look, this is where we're going, and there's some logical reasons, perhaps, why some good things may come of it. But to a certain degree, that's in our human nature, to explore and to reach out, or to try to do things that have never been done before.

So I guess my question is -- and I think that there's no harm in that being informed by some amount of intellect, and some knowledge and some thinking, of course. But some it's the hard thing -- is just, what do you want to do? So my question to each of you would be to talk to me now like you're a 12-year-old and just -- I want something that's more like, "Boy, if I could just do whatever I wanted to do."

You know, look out into space and tell us, you know, what's on your hearts to do if you had a chance to sort of -- you've got the magic wand, you can design the program: where would you like to see us going?

Thank you, Mr. Chairman.

BOEHLERT:

You can go on down the line.

GRIFFIN:

I think you've re-expressed the themes that I tried to capture in my written testimony. I agree with you wholeheartedly. And as far as being a 12-year-old, most of my colleagues would appreciate it if I would get up to the mental maturity of a 12-year- old.

(LAUGHTER)

HUNTRESS:

I think I've been a 12-year-old all my life, and that's why I'm in love with space exploration. And I think you're entirely right that the reason we will go to Mars is not for scientific reasons. The reason we're going to go to Mars is for explorations and for reasons that humans want to go there, that it's in our innate nature to look over the horizon, to try and discover, try and understand, and better ourselves with that. And that's the reason we'll really go, not for the scientific reason. Science will benefit, but it's not going to be the primary reason.

AKIN:

So in other words, your answer is Mars -- you think that's the next logical good thing to sort of -- we haven't done that yet, let's go do it.

HUNTRESS:

Yes. You know, if you were to put Mars and the moon at the same distance and say, "Which one do I want to go to"...

AKIN:

Mars, right, because we haven't been there yet?

HUNTRESS:

No. Not only that, but it's a much more interesting planet. It's the planet in the solar system with a surface environment most like our own.

AKIN:

Thank you.

KOSS:

I have a great respect for the vision of my fellow 12- year-olds, and I would like to see their vision come true, in some way. However, I'm a convinced matter physicist, and people don't find what I do as interesting as what they go, generally. But my interest, what I like, what excites people like me is looking at the inner structure and working of materials, and how they work.

NASA, right now, has a vibrant program in material physics, in combustion, in biotechnology, in fluids and fundamental physics. I would just hate to see this broader vision that is described so eloquently by members of this panel injure or destroy the physical science that's going on right now and going successfully. That's, perhaps...

AKIN:

Is that part of the budget that we're talking about here, those different component parts?

KOSS:

It is, because right now, that program is structured with human-enabled space flight as a majority of it. And in this further discussion on where the space program could go, that program could be dropped as not being quite dramatic. So it's a tremendously successful program that could, if you removed the humans from that

loop, could be done at a much greater savings and a greatly reduced risk.

And if you keep a program like that around, it will also inspire you, and it will complement the larger vision that NASA goes forward with.

AKIN:

Thank you.

ROLAND:

I'll just say that most of the explorers you mentioned had practical purposes for going, and it's one of the concerns I have, is why, for the time being, I'm more focused on low-Earth orbit, because I think that's where our practical payoffs are. And also, most of them had to raise their own money. Columbus paid 11 percent of the cost of his own voyage. He was buying in as an investment, and it's hard to see what the payoff of the explorations are. They're very exciting, but I don't see the payoff.

AKIN:

So historically, you're saying that the parallel is not quite the same here.

ROLAND:

Right.

MURRAY:

Getting directly to your question, rather than reconstructing my own theme itself, let me tell you about Cal Tech students, with whom I work, and I have for decades. A surprising number really want to go to Mars, but there's nothing there for them. They're counseled to go to something else.

Low-Earth orbit is a dead end. You don't want to take a talented person in science or engineering and get them bogged down in this bogged down program.

BOEHLERT:

The gentleman's time has expired.

AKIN:

Oh, okay. Thank you, Mr. Chairman.

BOEHLERT:

But if you had one quick comment, Mr. Akin...

AKIN:

I was just going to follow up on that last answer. You say that the idea of going to Mars, that's something that the students, you say they're interested in it. But what do you mean when you say there's nothing there for them?

MURRAY:

NASA has no program. There is no goal, there's no destination, and instead, we're bogged down in low-Earth orbit.

AKIN:

So you're saying we need to hold that vision out there...

MURRAY:

That's right.

AKIN:

... about going to Mars, and your students would get excited about that.

MURRAY:

Yes.

AKIN:

Thank you, Mr. Chairman.

N. SMITH (?): I wonder if the question might be more challenging if it was, "How would you feel as a 70-year-old, and you're being told that your Social Security payments are going to be dramatically cut, as well as your pension from whatever you earn, and where do you want the federal government to spend its money?" I mean, that's the challenge that this country is facing very dramatically.

And so, part of what I've heard Dr. Roland say and Dr. Murray is there's got to be some return on that investment. What is the practical return? And certainly, my opinion, as chairman of the Subcommittee on Research of this Science Committee, is that stimulating and exciting youth in math and science is part of it. I don't think, Dr. Huntress, the excitement of Sputnik is still there.

I mean, this program has been going since the '60s. It's lost some of its allure, it seems to me. Our challenge now, with half of our graduate students coming in from foreign countries, to do our research that's sponsored through the National Science Foundation, should scare the hell out of us.

It seems to me that NASA -- strike the word "hell" without objection, so ordered -- NASA has been sort of oriented to scientific research in the past, and I think it should continue that way. And to the extent that we can justify it as far as research endeavors that result in better products or better ways to produce, more efficient ways to produce those products, then certainly, we can support that.

Dr. Koss, in terms of your suggestion for satellites or, if you will, some pre-flyers up there, in terms of doing some of the scientific research more effectively, more cost effectively, what would be the cost of one of these satellites compared to a traditional satellite that we've been putting up? Is the cost of robotics, and the nanotechnology, and the communication system to conduct this research substantially going to increase the cost of those platforms?

KOSS:

I believe that the cost of autonomous science platforms has savings over the shuttle or station performing those experiments. And so, by doing more autonomous and remote experiments, even in the creation of a new facility for doing so, you save money by reducing the number of shuttle or station resources that need to go to performing those science experiments, which will free up funds for the broader vision that NASA has.

N. SMITH (?): Do you think there should be -- Dr. Murray?

MURRAY:

I want to comment, I'm 71 years old, living on a pension fund, and so I share that view strongly. I'm also a deep believer in human space exploration, so I'm caught. And that seems to me to lead to this painful thing I said: we've got to restructure the existing program and get money out of that to enable developing the vision we're talking about into something a little more real.

N. SMITH (?): Well, it's my guess, Dr. Roland, you suggested that maybe -- I mean, we know that the platform, the space station is way over budget. The prospects are that it could very well double again. In terms of its effectiveness as a research lab, should we separate the micro gravity research from how humans can exist in outer space type of research, and decide where we should go from there in terms of manned and unmanned?

ROLAND:

Right. I agree with Dr. Koss that the best science on the space station is the human physiology science. But in my mind, we are a long way from facing the prospect of long-term manned space flight, and that's not our greatest priority. So we ought to be using that space station as a space platform to conduct automated experiments, and then get on with making access to space more practical.

N. SMITH (?): Dr. Koss?

KOSS:

The Columbia Accident Investigation Board concluded, or one of their conclusions is that we need to separate humans from cargo. And I would submit that many of the basic science experiments, all of the physical sciences ones, and many life science ones, don't involve human beings, are essentially cargo, and can be separated from the human element, to great cost savings.

N. SMITH (?): Dr. Griffin, Dr. Huntress, would you even agree that in terms of exploring outer space, it's more reasonable to do that with unmanned space exploration?

GRIFFIN:

I think it depends on the kind of question that you're trying to answer. There again, as Dr. Huntress and others have said, for a long time, there has been this artificial feeling of a division between manned and unmanned space exploration, whereas in practice, it has not been that way. Pretty much, when people can automate something, they have done so, and when people are needed, people are used.

For exploration, the very nature of exploration suggests that humans have to be involved, in the sense that Doctors Murray and Huntress and I have been talking.

N. SMITH (?): Except that in recent testimony, our administrator of NASA said that we could very easily do the shuttling with unmanned space flights...

GRIFFIN:

I have no problem at all, and, in fact, I've strongly recommended that transport of crew and transport of cargo not be linked. I think that is the key design flaw of shuttle. But that does not imply that once the cargo is where you want it that it won't be worked on by people.

N. SMITH (?): Do I understand, then, that you and Dr. Huntress disagree with the idea that the scientific research could be done more efficiently on platforms, more efficiently in terms of cost and productivity of those research programs, rather than continuing the completion of the station?

HUNTRESS:

Let me try that one. I agree that most of the science which is done on shuttle space lab flights or on the space station, with the singular exception of research on human physiology in space, is probably more cost effectively done on manned platforms, or remotely operated vehicles, or human-tended ones. And so, I believe the station's greatest utility, if it has one, is in research on human physiology in space.

N. SMITH (?): And so, what do you see as the long-term economic advantage to this country as far as humans' physiological reactions to outer space?

GRIFFIN:

Well, the only reason that anyone would care about human physiology in space is to prepare the way to have humans go further in space. If one is inherently not interested in human

exploration of and expansion into the solar system, then there is no reason to study human physiology in space.

N. SMITH (?): And do I understand from your response that you think that that's a goal, a policy goal that we should have, whether or not it's driven by the economics of this planet?

GRIFFIN:

Yes, I believe a policy goal of the United States ought to be to expand human presence into the solar system.

N. SMITH (?): And for what reason?

GRIFFIN:

I've tried to indicate in my written testimony that I truly believe that it is part of what we are as human beings to want to do that. I have no better reason. I acknowledge that we cannot afford to spend a lot of money on it, and I think I've pointed out that we, in fact, don't spend much money on it, but that it ought to be done.

N. SMITH (?): Gentlemen, I'm going to offer my thanks and turn it back to the chairman.

BOEHLERT:

Thank you very much, Mr. Smith. I appreciate it.

I'm going to wrap this up. One question I'm going to ask, and I'm going to ask that you give some thought to it, obviously. You've given thought to everything you've said here today, but respond in writing, if you will. And this is the basic question, and we'll give it to you in writing.

Could each of you outline, with some degree of specificity, what you think NASA ought to be doing and not doing over the next five years in pursuit of your vision? Got it? All right.

Now, this is one that's through the whole hearing today, and listening to you, and the exchange, and the dialogue you've had with our colleagues here, I've come up with some statements. And I'd like to ask each of you, you know, a quick yes or no, if you agree with the statement, and I'll ask them one by one. Now, a lot of it is in the asking of the questions, and I know there are nuances, but I'm trying to get a general feeling.

The current NASA human flight program is not moving us toward any compelling objective -- the word "current" is the operative word -- and we should make a transition out of the shuttle and space station programs as soon as possible?

Dr. Griffin?

GRIFFIN:

Yes, I agree with you.

BOEHLERT:

Dr. Huntress?

HUNTRESS:

Yes.

BOEHLERT:

Dr. Koss?

KOSS:

Yes.

BOEHLERT:

Dr. Roland?

ROLAND:

Yes.

BOEHLERT:

Dr. Murray?

MURRAY:

Yes, yes.

(LAUGHTER)

BOEHLERT:

Thank you. Next question: the primary reason for human exploration is the impulse to explore, rather than any more utilitarian goal that you can quantify and measure immediately, although there may be collateral benefits.

Dr. Griffin?

GRIFFIN:

Yes.

BOEHLERT:

Dr. Huntress?

HUNTRESS:

Yes.

BOEHLERT:

Dr. Koss?

KOSS:

Yes.

BOEHLERT:

Dr. Roland?

ROLAND:

Yes.

BOEHLERT:

(OFF-MIKE)

We can take on ambitious goals without massive increases in the NASA budget. Instead, we need small increases sustained over a longer period of time.

Dr. Griffin?

GRIFFIN:

Very definitely, yes.

HUNTRESS:

Absolutely, yes.

KOSS:

Yes.

ROLAND:

Yes, except I don't think we need any increase, but long term...

MURRAY:

Yes.

BOEHLERT:

Well, you'd concede increase for inflation, wouldn't you?

ROLAND:

Yes.

BOEHLERT:

Okay. We should avoid sacrificing other NASA programs to achieve our human space flight goals.

Dr. Griffin?

GRIFFIN:

Yes.

BOEHLERT:

Dr. Huntress?

HUNTRESS:

Definitely, yes.

BOEHLERT:

Dr. Koss?

KOSS:

Yes.

BOEHLERT:

Dr. Roland?

ROLAND:

Yes.

BOEHLERT:

Dr. Murray?

MURRAY:

Yes.

BOEHLERT:

Boy, you're doing well. The long-term goal of the human space flight program should be getting to Mars and, preferably, starting colonies in space.

Dr. Griffin?

GRIFFIN:

Yes.

BOEHLERT:

Dr. Huntress?

HUNTRESS:

Yes.

KOSS:

No.

BOEHLERT:

Dr. Roland?

ROLAND:

No.

BOEHLERT:

Dr. Murray?

MURRAY:

Could I ask for clarification on the word -- I don't understand what colonies in space means.

BOEHLERT:

Well, out-stations, if you will, like we're talking about.

MURRAY:

Okay, yes.

BOEHLERT:

Yes, all right. So it's two to two, right, on that one?

(UNKNOWN)

Three to two.

BOEHLERT:

All right. Thank you all very much. And we could keep you here all day, and it just wouldn't be fair to you. We've got a million questions. I would appreciate it if, in a timely manner, you could respond to that one specific question I asked, and I'll repeat it.

Identify, with some degree of specificity, what you think NASA ought to be doing and not doing over the next five years in pursuit of your vision of what we should have in the future of human space flight. Now, I don't expect you to micromanage it and tell us chapter and

verse on how they should do everything. But I think you sense what I'm asking for.

Thank you so very much. I really appreciate it. And this hearing is now adjourned.

CQ Transcriptions, Oct. 16, 2003

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